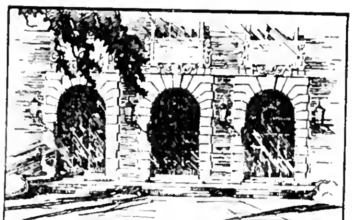


Field Museum of Natural History

~~Publication [illegible]~~

Museum Technique Series

No. 2

NEW USES OF CELLULOID AND SIMILAR MATERIAL IN TAXIDERMY

BY

Leon L. Walters

Taxidermist, Division of Reptiles

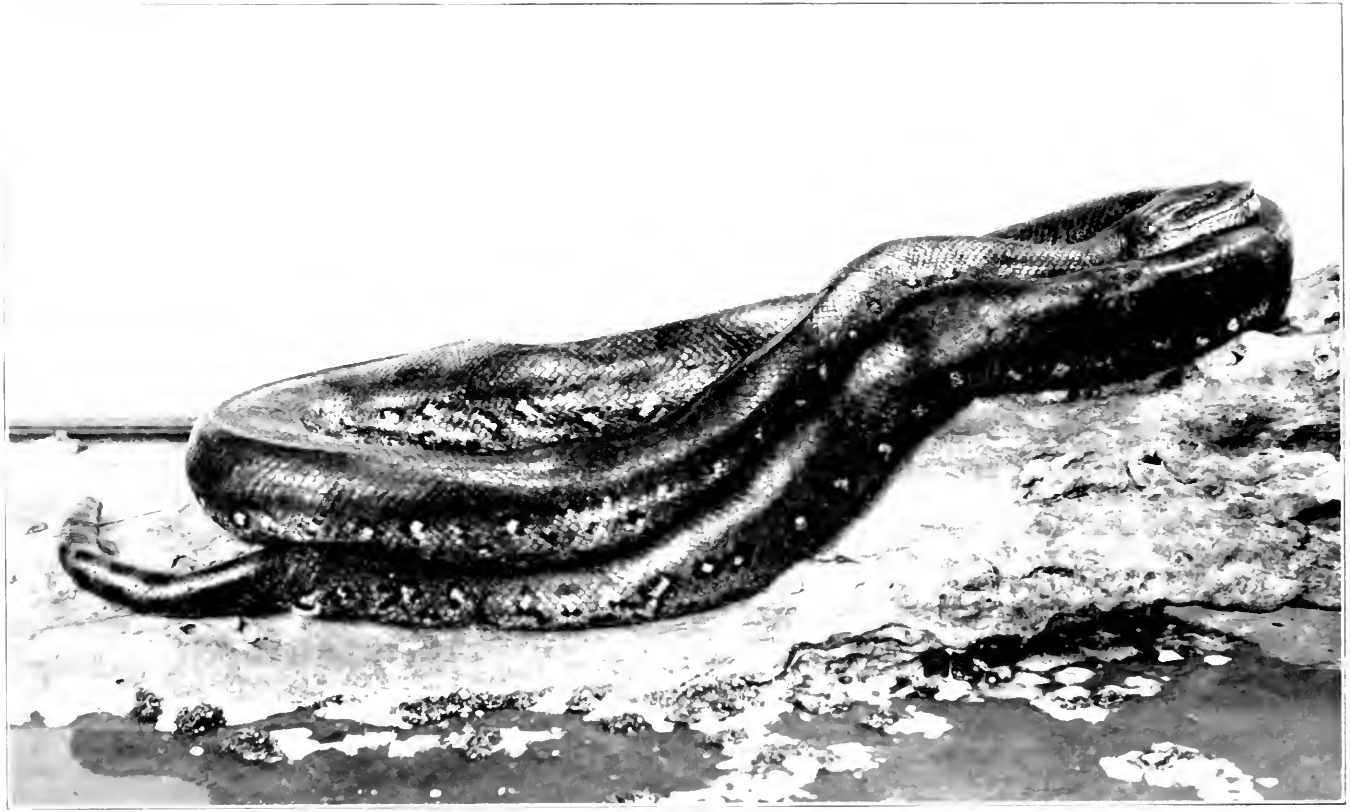
Wilfred H. Osgood

Curator, Department of Zoology

EDITOR

Chicago, U. S. A.

June, 1925



Reproduction of Anaconda.

FIELD MUSEUM OF NATURAL HISTORY

[redacted]

MUSEUM TECHNIQUE SERIES

NO. 2

NEW USES OF CELLULOID AND SIMILAR MATERIAL IN TAXIDERMY

BY

LEON L. WALTERS
Taxidermist, Division of Reptiles

WILFRED H. OSGOOD
Curator, Department of Zoology
EDITOR

CHICAGO, U. S. A.
June, 1925

mr. 2

NEW USES OF CELLULOID AND SIMILAR MATERIAL IN TAXIDERMY

BY LEON L. WALTERS

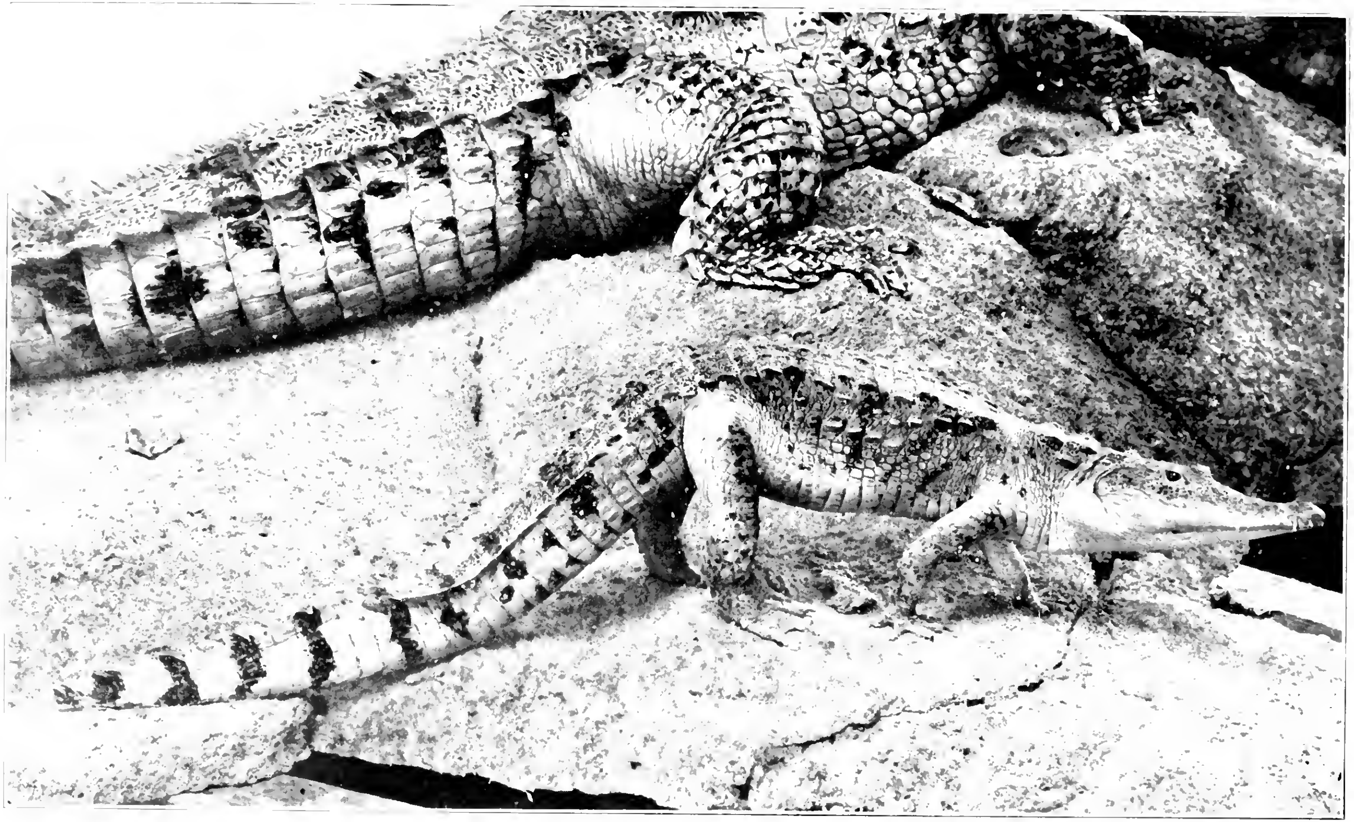
The present paper deals especially with the correlation of form and color in making replicas of natural objects. When this was first put into practice, in preparing small reptiles, celluloid was used as a medium in conjunction with pigment. The process has become rather generally known as "the celluloid process," although, strictly speaking, celluloid is only one of various materials that have been employed. In explaining this process, it is hoped not only to give practical suggestions for actual work, but to bring about a clearer understanding of the relation of form and color as they exist in the natural object.

Taxidermy has realism as its ideal and so every factor that contributes to what we see in a living creature should be isolated and studied. This brings up the question of just what constitutes all we see or regard as "life" or the appearance of life in the living model. Among animals many subtle phenomena exist. How much or how little any of them may actually contribute to our impression is speculative. If there be anything not expressed through form or color, it cannot be translated into glass, marble, celluloid, metals or other materials available to the taxidermist or sculptor. Motion, which is almost inseparable from the majority of subjects, has the greatest influence in forming our impressions; but we cannot have motion. Allowing for a suspense of motion, however, it is not established that the entire appearance of life does not lie within the limits of the various intricacies of form and color. It may be conceded that attempts to secure the appearance of life fall short of absolute realism, but before forming a theory to explain the failure, it should be made entirely certain that technical shortcomings are not responsible for what may be lacking. We accept many parts of a replica as being perfect. The replica, itself, may be but a part, such as an artifical human eye. Each feature will be compared with the real eye. If we can appreciate or suspect a difference, can we not finally resolve and attribute this difference to some

specific fault in color, translucence, form, proportion or marking? The difference may finally be found to be due only to the lack of contraction and expansion in the pupil.

Form refers to the general bulk of the figure, its anatomical structure, posture or attitude, and also deals with the most minute details of the surface. In color, besides the correct tint, we are concerned with duplicating the particular degree of translucence that is found in the various visible parts of the specimen. Pigments, as prepared for normal use, are very opaque materials. Although mixed with oils or varnishes, their opacity is not appreciably reduced. Natural objects on the other hand are relatively translucent and in them the coloring agents are scattered through a layer of considerable thickness, the colored parts having the appearance of being lightly pigmented. If a thin shaving is cut from the surface of a natural object, the shaving will appear much less colored than the normal area surrounding it. Quite a thick layer may be necessary to secure the full color effect. It is found that by taking artificial pigments, correct as to tint, and mixing them with the proper quantity of translucent material, a result can be obtained that, so far as the eye is concerned, will equal the object to be duplicated.

We will assume that the various considerations regarding form have been dealt with and that a mold of the object has been made. If we make a cast from this mold, its form will be exactly that of the object from which the mold was made. While the form is correct, the cast has only the monochrome color of the material used in its making. It is then necessary to color the cast, but any coating of pigment, however slight, rises above what may be called the true surface and the form is no longer correct. This change of form may not be great or may not be perceptible when translucence is sacrificed and the most opaque pigments are used for the coloring. However, it has been found that in the average instance, a thick coating of coloring material is required for the correct color qualities. This thick coating very decidedly alters the fine surface details of the cast. While a model of translucent or partly colored materials, such as celluloid or wax, could be cast in the normal way, there would yet remain the matter of applying the colors that are at variance with the general color selected. In this we have the problem just presented. To color the finished cast through the use of dyes would not necessarily alter the surface form. However, it will be shown that different colored bodies of varying degrees of pigmentation exist in definite locations beneath the surface. The surface layer may be translucent and practically uncolored, the main coloration existing directly beneath this surface layer. Very often the



Detail of a Group of American Crocodiles.

different layers are of strongly contrasting colors and the color effect of the whole is due to this particular arrangement. Dyes would necessarily color these surface layers as well as the deeper portions.

The obvious solution of the color problem is to apply colors to the mold and not to the finished cast. Each color is applied or painted in its proper location on the interior surface of the mold. In the final result the surface details remain unimpaired, all the colors appearing within the true surface. But slight reflection is needed to see that this condition prevails in the natural object. This briefly presents the fundamental principle of the process. After the application of the materials necessary to secure the full color appearance, layers of other materials, such as cloth and wire-cloth are added for further strength and support. The replica, entirely complete as to coloration, is then removed from the mold.

PROBLEMS OF FORM.

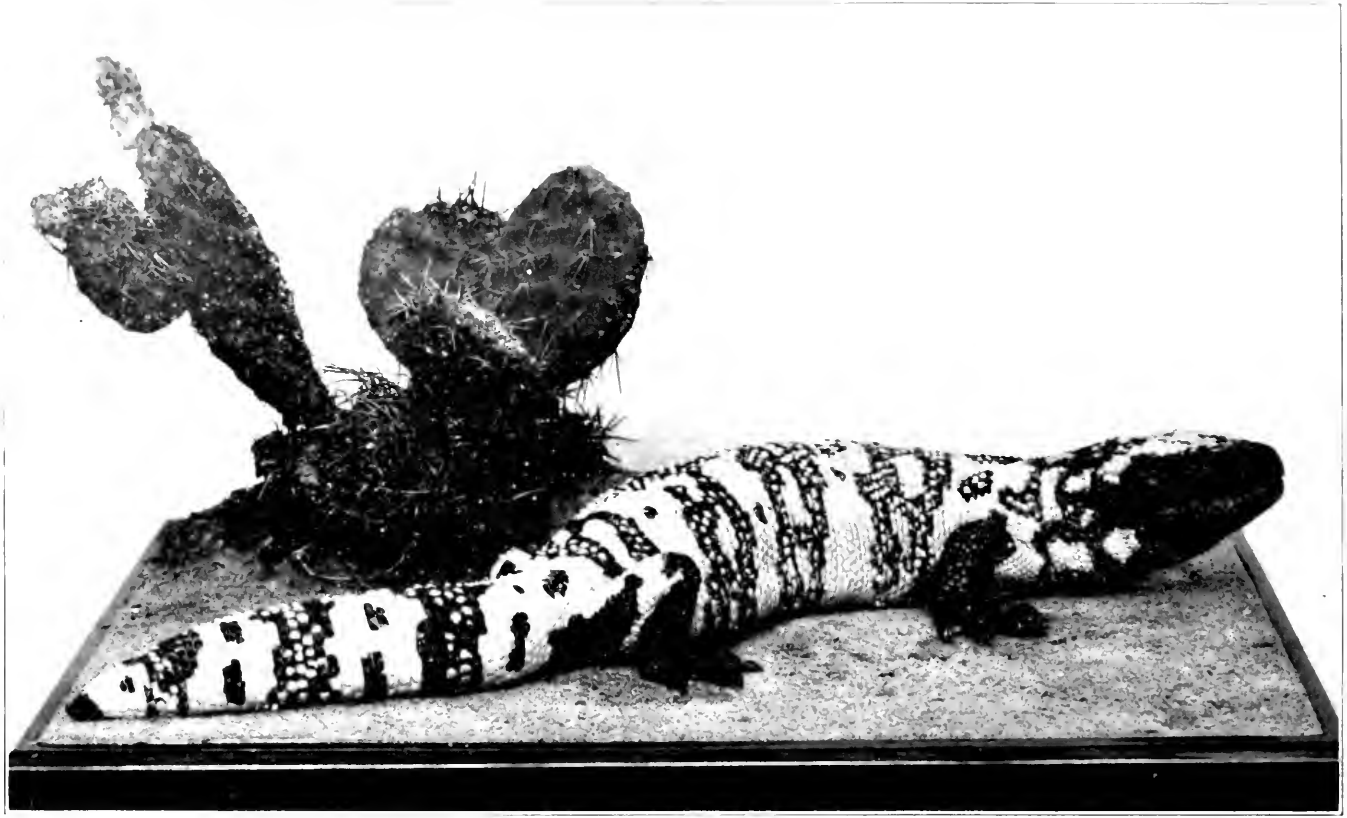
Field and laboratory studies of living animals.—If the exhibit is to have its greatest value, it is essential that studies be made of the animal in its natural home. The selection of an interesting phase of its life from a biological or from an artistic standpoint is made from such studies. The animals' habits may be well known and the general character of the exhibit may be determined upon beforehand, but even then, it is necessary to supply by direct observation and attention the innumerable details that are necessary to a truthful and convincing reproduction. Such studies have the same relation and importance to the museum preparator that personal sittings and studies have to the portrait painter or sculptor. With reptiles and amphibians field studies can be supplemented very favorably by further studies of caged specimens in the laboratory, but allowance must be made for the abnormal conditions. The value of such studies is mainly in the anatomical structure and details for use in coloring. In a general way, frogs and toads can be expected to act in a fairly normal way in surroundings that can be made nearly natural for them. The behavior of lizards may be expected to be farthest from normal.

In the course of studies made by Mr. Karl P. Schmidt and myself, in Central America, we observed that a captive crocodile did not walk but progressed by short rushes. However, under natural undisturbed conditions, crocodiles would swim to the edge of the water, stand high upon their legs and walk out on the bank. This dinosaur-like position assumed in walking was surprising and interesting and was chosen for one of the specimens for a group. These crocodiles would

lie on the bank for hours at a time, holding the mouth open. This peculiar habit is interesting, displays the interior of the mouth and shows the peculiar structure of the throat valve. The crocodiles would also lie motionless in the water with only the nostrils and eyes exposed. This shows an interesting adaptation to an aquatic existence. These were the primary reasons for selecting the positions chosen for the reproductions. In the case of these crocodiles, plaster was transported and molds of the reptiles were made on the bank of the lake where they were collected. Skins were preserved for pattern, and color notes were taken for later use in making the reproduction. Large specimens such as these present difficulties connected with the large amount of plaster required and the extra care necessary in packing the molds for shipment. The alternative is to remove the skin and preserve it together with the skeleton and data for its rebuilding in the laboratory. The plaster mold is then made from a reconstructed form.

The use of live specimens presents a number of advantages in this work where color is so important, and, fortunately, live specimens are very readily available among reptiles and amphibians. Ordinarily they are captured alive when collected. They can be kept captive in a sack or box and can be shipped without provision for feeding. Amphibians can be shipped in cans containing dampened moss, the lids punctured from the inside with holes for ventilation. All are easily kept in the laboratory, a feeding of once or twice a week, ordinarily, being sufficient to keep them in good condition. Occasional specimens do not do well and soon become emaciated. The plaster molding must be done before this occurs, for if no other specimen is available, it will be necessary before molding to remove the skin and adjust it on a carefully prepared clay model, a contingency to be avoided if possible. In most instances, a mold of a reptile or amphibian can be satisfactorily made directly from a freshly killed specimen.

Selection of specimens.—It is desirable that the specimen be in normal physical condition and present the average size of the species. It should be neither a record specimen as to size nor be much under the average. Care should be taken to retain the relative sizes of the species represented. An undersized specimen may be used as possibly being the best available at the time. Also, an oversized specimen of another, although smaller, species may be used. It seems a small matter at the time but, later, these specimens will be exhibited side by side in the same case, and, with reptiles as with fish, relative size is one of the points strongly impressed on the observer. The more



Reproduction of Gila Monster.

careful and detailed the technical work in the reproduction and the accessories, the more confidence the observer will have in other features of the work. The same applies to coloration. Often it may be necessary to consider exhibition of more than one specimen in order to cover the color variations, especially if distinct color phases exist. A study of the species in regard to relationship or taxonomy is necessary to determine and fully represent the characters of greatest importance. The number of exhibits that can be prepared is limited. Therefore, considerable care should be exercised in study of the species and in selecting the specimen that is to be perpetuated.

Composition and pose.—After studies have been made of the subject in the field, some interesting trait or habit desirable to represent will nearly always be discovered. This is the direct result of study of the animal in its natural habitat and involves judgment in selecting what is best to represent, due regard being given to technical problems of reproducing and final installation in the museum. The personal equation barely enters in the positioning of the specimen. This was the case in regard to the crocodiles referred to, although here, personal ideas are allowed some play in selecting and arranging the ground work and in arranging the specimens upon it.

In dealing with snakes, however, we have an additional problem. Few snakes have distinctive habits that would lead to an immediate choice of position. A cobra might logically be posed in its characteristic attitude with the forward part of the body reared off the ground and the hood spread. The rattlesnake has a characteristic position when it takes the defensive, the body being tightly coiled and the neck and head taking the form of the letter S. It would be very well to illustrate two or three of the dozen or so species that exist, in this position. Many snakes that live on the ground have no peculiar or distinctive habits that would lead to a choice of a position. It is with such as these that the personal element enters and the specimen is arranged according to the ideas of the individual in regard to composition or design. The snake lends itself readily to an almost unlimited variety of positions that are anatomically correct. Diverse angles and curves, when carried out in the arrangement of a snake, are usually accepted as giving the most pleasing design, and if the casual opinion of a number of persons is asked, nearly all will agree that certain arrangements are decidedly more pleasing than others. The same influences that are common in regard to design in art apply here. Used judiciously and closely limited, design, while in itself having no relation to the problem of making a truthful natural history reproduction, may

become an asset, but when persisted in without close restraint throughout an entire series, the effect is monotonous and displeasing. An injudicious display of this tendency is unfortunately in evidence in nearly all work on snakes. In any event, the specimen should never have the appearance of being designed, and it is better not to use theories and ideas in regard to design that, in this work, would produce a recognizable similarity and duplication when a number of specimens finally occupy a single case.

Preparation of the specimen for molding.—The preparation of the specimen for molding and the working of the molding material are of great importance. If the model cannot be brought to a state entirely satisfactory as to form, the reproduction will necessarily preserve the same objectionable features. If detailed surface form is lacking or is lost through poor molding, then this process will be of little utility. Before molding, the specimen should be fully restored to life-like condition in so far as form is concerned. As in all taxidermy, a thorough study and familiarity with anatomy in relation to modelling is necessary. Even when a mold is to be taken immediately after the death of a reptile, it is necessary to study during life the positions of all the parts that would be influenced by death, so that before molding they can be restored to their life-like positions. Failure to detect the small changes that take place after death and to restore them is one of the reasons why casts have been, in general, unfavorably considered. Restoration of the eyes, for example, to their life-like position is nearly always slighted. Among amphibians and reptiles, with the exception of snakes, the eyes are retracted on the death of the specimen. The eyeball must be brought to its natural position before molding. It may be necessary to cut certain of the eyelid muscles, or to entirely remove the natural eyeball and replace with an artificial eye. Proper support of the abdomen, throat and other parts must be provided. If this cannot be accomplished with the freshly killed specimen, the remedy is to make the necessary studies, remove and preserve the skin and, later, in the laboratory, adjust this skin on a reconstructed clay figure. When this is contemplated, the skeleton should be saved to accompany the skin and the anatomical studies and casts that are made in the field. The fine details of skin texture need no particular attention in fresh specimens except with frogs and toads in which the warts often flatten down soon after death.

All possible preparation and study should be made before the specimen is killed so that after killing, the work of positioning, restoring and molding can take place without delay. If the specimen is

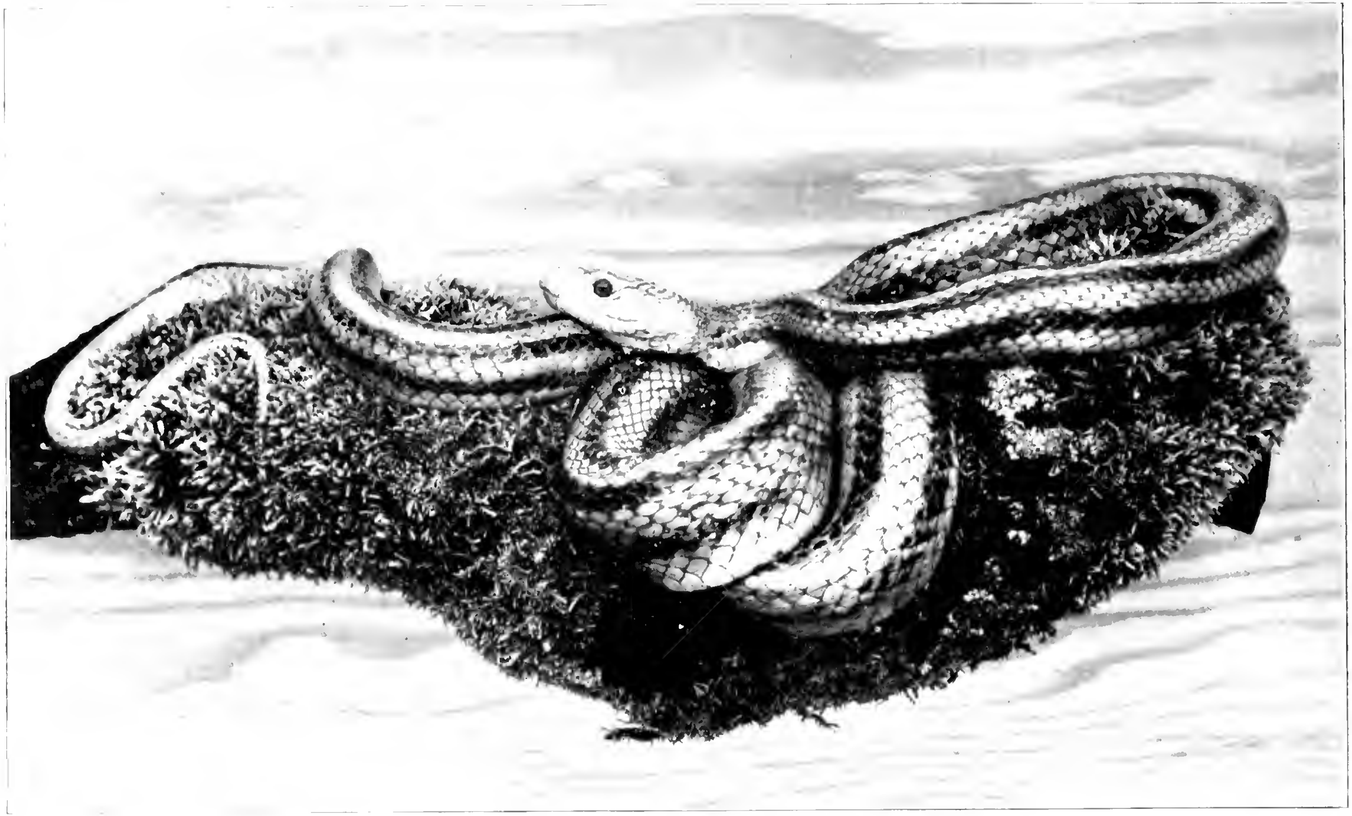
to lie on a branch or any part of a log, the selection of this branch or log should be made beforehand. Details of the position can be arranged after killing, but the general position should be determined in advance.

Methods of killing.—In killing the specimen, the requirements are that it be accomplished as readily as possible and that after death the muscles shall be relaxed. Drowning is very satisfactory in most cases. During the winter it is not always possible to do this unless the specimen is placed in warm water, as at that season, when placed in cold water, reptiles and amphibians readily pass into a state of suspended animation and are not harmed. A saturate solution, about 1 to 100 of chloretone (a chloroform deriviative) and water is useful, especially for amphibians. Specimens placed in this liquid are quickly killed and the muscles are left relaxed. Often shortly after death, warts and protuberances in the skin of frogs and toads lose their plumpness and full size, and the specimen is no longer useful for molding. The molding of the specimen must take place before this occurs.

Use of skins and preserved specimens.—Remarks, so far, have dealt mainly with the use of live specimens under favorable conditions. There are many cases where live specimens cannot be obtained. The only available material may be in the form of an old mounted specimen, a dried skin, an alcoholic, a fresh salted skin or a skin in pickle. When a skin has been allowed to dry, the surface form is greatly altered, due to the wrinkling, shriveling and flattening that takes place. With the mounted specimen or dried skin, the skin must be placed in a bath, usually of salt water or fresh water with an antiseptic added in order to soften and plump it to a condition comparable to that of a fresh skin. When this is accomplished, as in the majority of cases it can be, a clay figure is constructed and the skin is adjusted and modelled on this figure. In addition to softening the skin sufficiently to permit its proper adjustment, the finer details of the skin surface, of tuberosities, of scales and wrinkles must be plumped to their original full form as in life. In the alcoholic specimen, the details of the skin surface are usually well preserved. The hardening, due to action of alcohol and other preservatives, such as formaldehyde, must be sufficiently overcome to allow for the manipulation and adjustment of the skin. This cannot always be done, but long soaking in salt water will greatly improve the condition. If the skin is a freshly salted one, or is in salt brine pickle, it is only necessary to wash in fresh water sufficiently to remove the excess salt. With dried skins, old mounted

specimens, or any skins in doubtful condition it is generally possible to remove a part for preliminary experimentation. While such skins can be brought to a condition in regard to the surface details of form that would be a great improvement over their previously shrunken and shriveled state, it is not always possible to bring them to the condition desired. The importance of these details cannot be minimized. Any treatment of the skin that has an astringent action, or even the slightest drying, results in changes of form that are universally characteristic. The eye generally recognizes even the smallest changes that take place, although the mind may not be able to readily analyze and point out these changes.

With extremely rare species, it would be possible to restore a specimen, approximately, even by resorting to modeling the skin surface, but cases warranting such expenditure of time, coupled with the inevitable inaccuracies, will be very few or none. Usually such specimens lack reliable color notes or other data for proper anatomical construction of the figure and correct posing in a natural surrounding. A scientific institution has no need or desire to wander too far from the paths of actuality in its exhibits any more than in any other branch of its work. A fabrication in form and color can be no less a misrepresentation than if it were in written words. The worker should know the requirements of his work to the extent that he can determine what he can do and what he cannot do with the material available. He should recognize the difficulties with each particular piece of work and determine, beforehand, whether or not he is in a position to overcome these difficulties in a reasonable manner. Lacking usable data regarding the life or habits of the species, he supplies it if he can. He looks up color descriptions and checks up color notes with markings that may remain on alcoholics to determine whether or not he can use them with assurance of a reasonable degree of accuracy. A skeleton and photographs may supply information as to anatomical construction, while the skin itself or a small sample of it can be experimented with in order to discover whether or not it can be plumped to a condition in which the surface detail will approximately equal that of life. Even with everything else satisfactory, there may be some outstanding problem in connection with the color which the experience and experimentation of the worker at the time may not be sufficient to solve. It is wise then to drop that particular job and turn to something else that can be done properly. At a later time a way may be discovered to overcome the previous technical difficulty or supply the missing information. Then it is time to do the work. At the best, there are



REPRODUCTION OF FOUR-LINED CHICKEN SNAKE.

many technical complications and difficulties in the work of making a reproduction of this kind, and in spite of the greatest care, a large percentage of errors will creep in.

While this process may appear to be primarily a process of coloring, it must be remembered that the great object of the difficult and tedious application of the colors to the interior of the mold is preservation of the details of correct form. Anything unsatisfactory in the form will be perpetuated in the reproduction. The particular defect will stand out above all merits, and the specimen will be remembered by its faults rather than its virtues. Features that are correct are passed by without particular thought except to note that they are as was intended.

Molding.—The molding is a vital step between the original model and its final reproduction. No matter how satisfactory the model may be, defective molding will ruin the result. In any case, the final form will be no better than that obtained in the mold. The making of plaster molds and the proper handling of plaster is a matter of experience and close study. It may be years before a careful workman will be reasonably satisfied with his plaster work. Satisfaction may often mean a relinquishment of ideals but this is not necessarily so. It would be futile and misleading to attempt to lay down rules to guide work in which only observation, experience and long, careful study lead to results. The present process requires the mold to be made in such manner that every part of it is accessible in order to do the coloring that follows. Snakes, turtles, and many subjects will be posed for lying positions and so quite an area of the under surface of their bodies is hidden. As this is not seen, it need not be reproduced and will then present an opening through which much of the coloring can be done. The head and neck or other parts must be made in sections, using various piece mold processes. Often it is possible to mold the part entire with strips of tin or lead inserted in the body of the mold where it is desired to have the line of separation. The strips should not quite touch the specimen. After the plaster has completely set, separation is brought about by breaking, the strips of tin controlling the line of fracture. The best result is obtained when the line of fracture disappears on joining the two halves thus produced. An objection is in an occasional broken fragment which must be saved and replaced. All molding must be done without disarranging parts of the specimen by the pressure of supports or dividing strips.

The plaster should be very hard when set, otherwise a film may detach and remain on the surface of the specimen and points may be

broken or rubbed off when the specimen is removed from the mold. Generally speaking, the hardness of gypsum plaster is in proportion to its density, and so it is desirable to use the minimum amount of water consistent with the requirements of handling. Also, a thin section of plaster will be harder on its inner surface than a thicker section of the same plaster. If the surface of the specimen is smooth and polished, the surface of the mold should appear glassy and polished. The mold surface should be free from bubbles. One of the common causes of surface bubbles is the adhesion and inclusion of air, mainly in cavities between scales and in sharp depressions. These can be removed by applying the first plaster to the surface and into the cavities with a soft brush before the bulk of it is applied. All but the smallest molds should be reenforced with a plaster and fiber coating as a precaution against breakage in handling.

Many amphibians have slimy surface secretions, albuminous in character, that prevent the proper setting of plaster. There are several ways to render these albuminous substances inactive on the plaster. Treatment with a coagulating medium previous to molding is apt to cause a hardening of the skin and bring about other changes detrimental to form and the easy positioning of the specimen. Probably the best procedure is to pose the specimen as quickly as possible in a lifelike position and without treatment of any kind, to depend on a coagulating medium that can be included in the plaster mixture. Alum seems to serve this purpose fairly well. Besides acting as a coagulant of the albumen, it combines with the plaster, causing an accelerated and more complete recrystallization.

The colors, bound in cellulose nitrate or acetate, can be painted directly upon the plaster surface of the mold, although it is occasionally advantageous to employ a method of separation, the principle of which was employed by Carl E. Akeley in making up his mammal manikins and which is in general use today in manikin work. This consists in sizing and surfacing the mold with the thinnest possible film of a material that is unaffected by the cellulose acetate or nitrate solvents used in making the model and is, itself, soluble in solvents that will have no effect on the model. In ordinary practice, in connection with cellulose acetate or nitrate models, when the model is completed and ready for the removal of the mold, the mold is placed in water. The water softens the plaster and it is readily broken away and any fragments of plaster still adhering to the reproduction are removed with a stiff brush. If a sizing of gelatine, casein, gum arabic or other water soluble material has been used, this sizing is dissolved on the final

soaking of the mold in water, thus cleanly releasing the model from the mold.

COLORING PROBLEMS.

General problems.—In making replicas of natural objects, such as are now being considered, coloration requires altogether different procedure from that for which pigments are designed and normally used. Ordinary painting is coloring a surface with a coating of pigment mixed with a drying oil or varnish, either for protection or for the purpose of decoration. Other things being equal, the pigments most desired for use in painting are those that when finely divided have the greatest covering power. It is among these commercial pigments that we find our coloring agents, but their use in the usual manner is impossible.

Throughout nature, we have relatively few objects that present the same appearance to the eye. Form is often the primary means of identification. However, with form eliminated and with two equally smooth and polished surfaces, we may in one case, have marble, and in the other, granite. The relatively greater general translucence of the marble is evident and is recognized by the eye, and this does not at all mean that the object must be held between the eye and the source of the light. The eye is trained in making analysis and identifications of this kind. The surface has its form, variable, characteristically modified or very exact, and this we recognize. Aside from that, we see below the immediate surface and through the different bodies which may be of every degree of translucence or opacity. The object may be as opaque as the commercial pigments, themselves, which are selected in part for their opacity, but this is very rarely the case in plant and animal life. From this point of extreme opacity, there will be a gradual reduction in pigmentation until a point nearly as clear and as translucent as glass is found. As an example, in a snake we have a nearly colorless transparent scale on the abdomen. In a layer below this is the pigmentation which approaches the general tone of ivory. In making a reproduction of this, it is necessary to reproduce all the parts in their various degrees of translucence as well as in correct tint. Also, they must be located in their proper order, first the nearly transparent surface scale and then below this the successive colored and partly translucent areas. Artificial ivory was never successfully reproduced until these conditions were exactly met. Although ivory and its natural pigmentation are chemically unrelated to the mediums of the reproduction, celluloid and zinc white, it is impossible

by sight alone to distinguish between the real and the artficial. This is due to correctness of details in regard to translucence and arrangement. The vertebrate eye furnishes an exaggerated example of such arrangements, as do also the fins and scales of fish. We are not deceived by these outstanding examples as we are with the more subtle and less pronounced problems represented in the great majority of subjects. A human hand furnishes an interesting study in this connection. The veins are overlaid by a rather thick dermal coat of different coloration. The nails present an interesting problem of a translucent surface with the coloration in the underlying parts.

Another type of coloration, wholly dependent on structural forms, is found very generally in fishes and, occasionally, in amphibians and reptiles. This produces the iridescent so-called metallic colors which exist in combination with pigment colors. Often their source is deep-seated but in other cases they originate on or are reflected from the surface of the scales or skin. These conditions are not successfully reproduced. Artificial pearls are now made from the silvery substance found on the scales of small fish. An industry developed in the Mediterranean regions supplies this material. This substance can be dyed or colored to approximate some of the conditions in the real pearl. The effects seen in mother of pearl are due to minute convolutions in the shell layers. The combined effect of the numerous translucent shell layers is barely perceptible when a cast is made of the surface layer only. With but few exceptions, the coloration due to structural forms has the general appearance of the opal. Opals are not now artificially reproduced, so at the present time, we are limited to the use of commercial pigments, dyes, fish scale pearl and the variously colored bronzes as coloring agents in attempts to secure the effect of this type of coloration.

Use of pigments in a translucent medium.—Excepting the examples of structural coloration above mentioned, it has been found that the conditions of coloration can be reproduced by utilizing ordinary commercial pigments added in carefully guaged amounts to a translucent material. In practice, the transparent material is reduced to a liquid state and then incorporated with the appropriate coloring materials. The solvents on evaporation leave colored translucent masses that can be made to resemble any particular part of the model. In order to give these colored masses or colored layers their proper location within the body and still preserve the surface detail as obtained by molding, the colors are applied to the interior surface of the mold of

FIG. 1. REPRODUCTION OF GREEN TREE FROG.

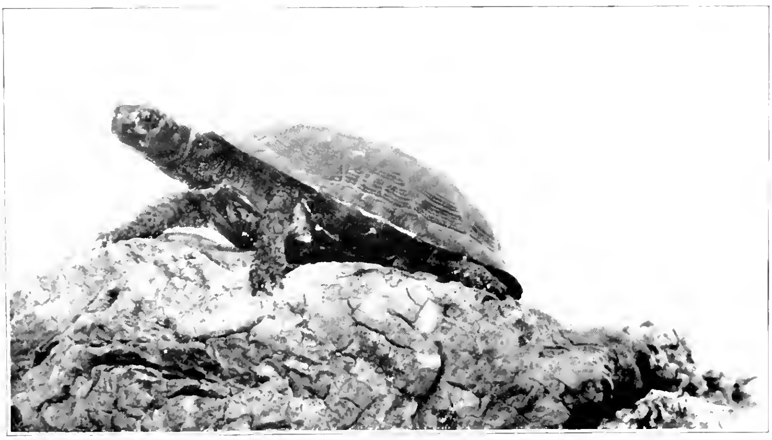


FIG. 2. MUHLENBERG'S TURTLE.

Reproduced soft parts combined with original shell.

the object, first the surface colors and following these the underlying colors or markings in succession. Each section can be given its proper relative position with respect to the surface and its individual degree of translucence.

The thought will occur that this is not so much a process of coloring as of making a model. This is exactly the case. The ideal sought is that of making an exact duplicate of the specimen as it appears in life. Whatever process is necessary to approach this ideal must be adopted. The colored materials are to be washed on, put on with a knife, needle, brush or by any method that serves the purpose and does not leave evidence of man's handiwork. Brush marks and similar effects cannot by any process of reasoning be justified here. Reason is too often clouded by custom and accepted methods of an established art tend to be used regardless of real applicability.

WORKING MEDIUMS.

Qualities required in translucent materials.—The material used as a translucent basis for the colors should be in the original state as nearly transparent and free from color as possible. A material having an initial translucence that is almost perfect is necessary in obtaining the brightest tints. The working out of complicated patterns and the coloring of the material, itself, call for its reduction to a liquid state. It must permit thickening and thinning, and applying with much the same facility that paints and varnishes are applied. There should be, after application, a reasonable and controllable rapidity in drying and solidifying. The materials, themselves, must be able to withstand without change the conditions to which the finished product will be subjected. These include the effects of dampness, heat, cold, dust, cleaning and handling, and the accidents to which a museum specimen is subject in the course of time.

Many materials which are useful in some instances cannot be used in others. All have their disadvantages. Any material, to be successful, will require much study and experimentation, and to say that a particular one is not usable may only mean that the difficulties have not been sufficiently studied. Casein and gelatine have qualities that make them applicable in this work. The varnish gums and drying oils, and especially linseed oil, are valuable and useful. Cellulose acetate and the cellulose nitrate products, pyroxylin and celluloid have been most generally used. The term "pyroxylin" applies to the cellulose nitrates that are soluble in amyl acetate and other commercial solvents. They have a nitrogen content varying from 10.5 per cent to 12.2 per cent

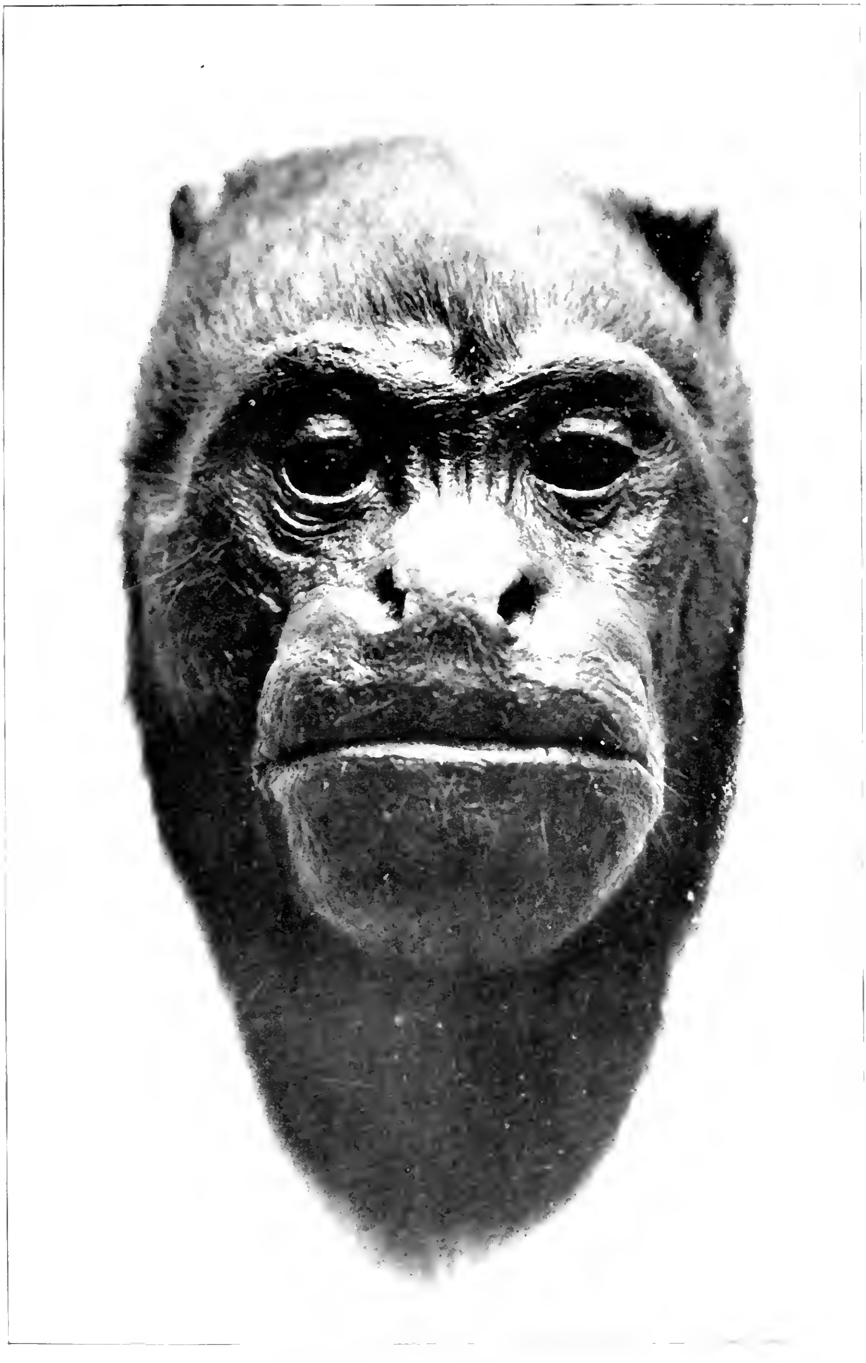
and are used in lacquering and waterproofing solutions, in the manufacture of artificial silk and leather, and in many other processes in which the handling is through the use of solvents. Cellulose nitrate, alone, is not moldable, but when it is mixed with camphor the resulting product, with the aid of heat and pressure, can be molded. The term "Celluloid" was the first trade name applied to this product and is still the most widely known. It is generally established as applying to all the moldable cellulose nitrates, and is used here in this sense. Other well known trade names of moldable cellulose nitrate products are "Pyralin," "Zylonite," "Xylonite," "Fiberloid," "Viscoloid," and "Cellonite."* In the manufacture of pyroxylin, primary considerations are uniformity of solubility and viscosity. Celluloid is soluble in the usual pyroxylin solvents, but as it is designed for molding and not for use as a lacquer, there is much variation in the degree of solubility and viscosity. When used as a lacquer, the ingredient, camphor, while normally of no value, has no detrimental effect.

Cellulose nitrates.—The cellulose nitrates, in their original state, are transparent. They can be dissolved in a rather large range of solvents for many and varied classes of work. The solvents employed are not dangerous to health if common precautions are taken for removal of the fumes with hoods and fans. The solutions are of very high viscosity, said to be seven times that of an alcohol-shellac solution, and this presents much difficulty and inconvenience when it is desired to deposit heavy layers. It is not possible to reduce this viscosity greatly although there are means by which it can be lessened. The flexibility and degree of hardness of pyroxylin are satisfactory. Specimens made of this material will withstand accidental blows and dropping on the floor without being damaged. It is water-proof and the specimen can be washed at any time with soap and water and, if necessary, scrubbed with a stiff brush. The coloring, being beneath the surface, is unaffected by any kind of abuse that will not actually destroy pyroxylin. It is unaffected by ordinary changes of temperature. If heated to 336° F, it decomposes, but as a general rule does not inflame. If a sample is brought into contact with a flame, it will ignite and the flame will travel through the mass, but it can generally be extinguished by a sharp breath of air. It is interesting to note that

*For information on the general subject, without reference to the particular problems of the taxidermist, two important works by C. E. Worden are available. These are:

Nitrocellulose Industry. 2 Vols. New York, 1911.

Technology of Cellulose Esters. D. Van Nostrand Co., New York, 1916.



FACE OF BLACK HOWLING MONKEY.

Reproduced soft parts combined with original hair. (Muzzle slightly foreshortened.)

holes can be bored through a mass or sheet of celluloid with a red hot iron without the ignition of the mass. Opticians often wave celluloid spectacle frames back and forth above a flame in order to heat sufficiently for bending.

Cellulose nitrate and its products, in the original state and without additions, are subject to deterioration. This is said to be due to faulty methods of manufacture and to the fact that the nitric acid, while originally combining with the cellulose, tends in time to free itself from combination. In the free state, it affects the cellulose, making it more brittle and giving the mass a characteristic brownish tinge. This action is hastened by exposure to heat and light. Such deterioration does not always take place, at least not at the same rate, for some samples do not show perceptible change after several years of exposure. The brittleness is not of serious consequence as it is only evident on flexing, and in this work the surface coatings are joined to a solid structure, but the change of color is very important as all the brighter colors would be affected. Any neutralizer of the acid as it develops, will retard or entirely offset this detrimental action. The range of neutralizers that can be incorporated in a water white celluloid, and still not affect its clearness, is limited. With pigmented celluloid, however, a large range of effective neutralizers is available, most pigments as well as white lead and zinc white rendering the product stable. I have organ keys containing zinc white as the pigment which show no apparent deterioration after forty years. In view of the uncertainty as to the stability of different samples of cellulose nitrate, it is desirable to use celluloid, pyralin or similar material that has withstood the effects of time and exposure incident to service for at least several years, and has still retained its original clear color and flexibility. To this, when reduced to a lacquer, neutralizers should be added as a further precaution, and in coloring, so far as possible, acid neutralizing pigments should be incorporated. Although this practice may not be entirely sound, it seems to justify the use of celluloid instead of pyroxylin, the cellulose nitrate which is designed for and is best adapted for lacquer work.

Cellulose acetate.—When cellulose is treated with a mixture of acetic anhydride and acetic acid, products are obtained having the appearance and general properties of the cellulose nitrates but possessing also some distinct advantages. These are known as the cellulose acetates. Cellulose acetate is not moldable but becomes so with the addition of camphor. "Cellit" is a trade name given to a cellulose acetate con-

taining camphor and stands in the same relation to cellulose acetate that celluloid does to the cellulose nitrates.

Cellulose acetate has the hardness, the flexibility, and the initial transparence of the cellulose nitrates. In motion picture films, in which it has the greatest field of use, it is much less inflammable than the nitrate. Although inflammability is frequently mentioned in connection with museum preparations, it is really of little consequence. The finished specimens will never be subjected to such conditions as prevail in the use of films, and a case of spontaneous ignition in an isolated body of cellulose nitrate, if it does occur, must be very rare. We are surrounded by innumerable cellulose nitrate products and it is probable that no one reading this has ever personally experienced a case of spontaneous combustion in such a body. Cellulose acetate, when subjected to tests, shows a stability much beyond that of the nitrate. It also has an advantage over the nitrate in the fact that any possible release of the acetic acid used in its manufacture can do no harm, as acetic acid does not, in small quantities, have a harmful effect on cellulose. Solutions of cellulose acetate have an equally high viscosity when compared with the nitrate. Many solvents are common to the two, while each has a series of solvents in which the other is insoluble.

FUTURE PROBLEMS.

Technical study.—An extended technical study is necessary for the successful handling of cellulose acetate and cellulose nitrate and their products. The actions and properties of the solvents and non-solvents utilized must be tested by many experiments. Progress is not possible without study and familiarity with the materials sufficient to enable the compounding of formulae to fit the many variable needs as they arise. These problems must be experienced to be understood. For reference, a record of all formulae and experiments, whether successful or not, should be kept on filing cards. There are many interesting problems of technique which, at the present time, are not completely solved. Rapid progress is being made and it is hoped to reach definite conclusions, soon, in regard to the most important matters. Full discussion of these would be premature and is beyond the scope of this paper.

Scope and possibilities.—Although especially adapted and first applied to reptiles and amphibians, the foregoing discussion of principles and methods applies to practically every branch of work with which a museum preparator has to contend. Plants with complicated coloration often present details of surface form that it is desirable to pre-

serve exactly. The feet and bills and exposed skin surfaces on the heads and bodies of birds are important subjects. Young birds are outstanding examples. Many of them are entirely naked, and the tissues are often so translucent that the viscera and other abdominal organs and many of the bones are distinguishable. Thinly haired mammals or mammals with exposed skin surfaces are subjects in which the skin coloration and fine details of form are of vital importance in connection with a life-like appearance. Most of the young of mammals are hairless. Many others are so thinly haired that the glow of the skin surface, especially with the lighter fleshy tints, decidedly affects the general color appearance. To extend these methods to mammal work, the variation from the regular procedure requires a method which provides for the correct transference of the hair. This first calls for the construction of an armature and a clay figure in the ordinary way. The skin in a freshened, soft and plump condition is adjusted on this form. The molding material, typically plaster, is applied in such manner as to entirely surround the individual hairs and take an exact impression of the skin surface between. When the mold is completed and re-enforced, it is separated along lines previously established, and the interior clay structure removed, the skin remaining attached to the mold by the embedded hair. Through dehairing treatments, such as are in use in tanning operations, the tissues surrounding the hair roots are acted upon and the skin detached and removed from the mold. The mold then presents an accurate negative of the skin surface with the root of each hair protruding and exposed. The colors are prepared and applied in the usual manner, the liquid cellulose acetate or nitrate surrounding each hair root. On the evaporation of the solvent, the hair is left enclosed and embedded in the solidified material. As a means of support, this artificial skin is continued into alternate layers of cloth and wire cloth, the resulting structure being similar to that used in ordinary mammal work. The removal of the mold leaves the specimen complete with the natural hair set in an artificial skin which has correct color and translucence. In this mammal work, molds have been made of plaster compositions, of waxes and of other materials and, therefore, different methods of removing them have been employed.

Future Taxidermy.—The idea is widely accepted that taxidermy is necessarily an art of low standing. It is full of great technical difficulties and these are sufficient to account for the grade of work produced from which opinion is formed. As these difficulties are over-

come, a gradual recognition of its possibilities and an increasing interest in it may take place.

Sculpture is devoted to expression through form. Stone and metals, into which its work is finally translated, preclude the possibility of complete realism. Such realism is dependent not only on color and general form but on the most minute detail of the surface structure. This can only be obtained by direct molding of actual surfaces; it cannot be modelled in clay or cut in marble and is, therefore, outside the possibilities of sculpture.

Realism, therefore, is the province of taxidermy. It has a distinct field of its own, well worthy of the best effort. In this field, the possibilities by no means have been exhausted and it is to be hoped that the future may see much further progress.

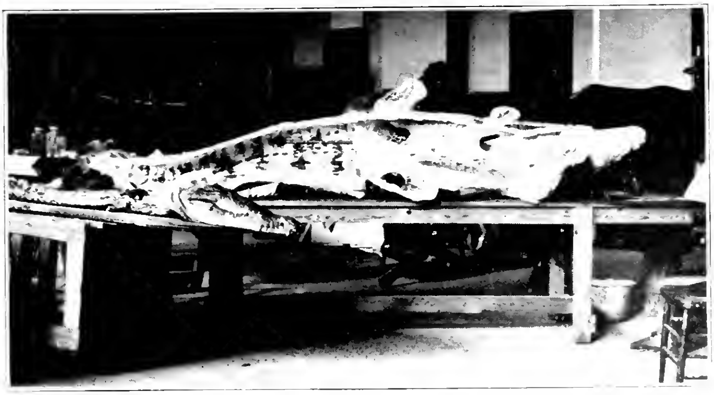
EXPLANATION OF PLATE VII.

Fig. 1. Waste mold of a crocodile, made in four pieces, two of which are joined.

Fig. 2. The mold after partial application of pigmented celluloid. The coloring is continued and followed by reenforcing materials to give strength to the model. The preserved skin shown in the foreground is used as a guide for color pattern but the tints are based on detailed field notes.

Fig. 3. The completed model of the walking crocodile, shown in Plate III, emerging from its plaster case. The plaster, softened by water, is chipped away with hammer and chisel.

1



2

3